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Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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In Re Application of:

Pippin, Jack

Application No: 08/660,016

Filed: June 6, 1996

For: METHOD AND APPARATUS FOR PROGRAMMABLE THERMAL SENSOR FOR AN INTEGRATED CIRCUIT

Continuation of:

Application No: 08/124,980

Filed: September 21, 1993

Examiner: Siek, Vuthe

Art Unit: 2764

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231 on

March 5, 1998.
Date of Deposit

Michelle J. Turner
Name of Person Mailing Correspondence

Michelle J. Turner 3-5-98
Signature Date

Assistant Commissioner for Patents
Washington, D.C. 20231

Peggy, please enter Thanks, Thompson 1/1/98

## Appellant's Brief (Pursuant to 35 C.F.R. § 1.192)

Dear Sir:

Applicant (Appellant) respectfully submits this brief in connection with the above-referenced application on appeal to the Board of Patent Appeals and Interferences from the decision of Examiner Vuthe Siek of Group Art Unit 2764, dated October 3, 1997, finally rejecting claims 1-19.

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## I. REAL PARTY IN INTEREST

The above-identified application for patent is assigned to Intel Corporation of Santa Clara, California, the real party in interest.

## II. RELATED APPEALS AND INTERFERENCES

A Notice of Appeal has been filed for related pending application no. 08/636,024 of Jack D. Pippin filed April 19, 1996 entitled Method and Apparatus for Programmable Thermal Sensor for an Integrated Circuit. Application no. 08/636,024 is continuation of application no. 08/401/473 filed March 9, 1995, which is a divisional of application no. 08/124,980 filed September 21, 1993.

Appellant submits that any decision rendered by the Board with respect to the appeal of application number 08/636,024 may affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

Appellant is unaware of any currently pending interferences that may directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal. However, appellant has attempted to provoke an interference in the present application and anticipates filing a Request for Declaration of Interference. With respect to related application 08/636,024, appellant has already filed a Request for Declaration of Interference.

Appellant respectfully submits that any decision by the Board in the present appeal may affect or be directly affected by or have a bearing on the

Board's decision with respect to interferences resulting from the present application or related application number 08/636,024.

## III. STATUS OF THE CLAIMS

Claims 1-19 and 37-39 are pending. Claims 1-19 were rejected by the Final Office Action dated October 3, 1997. In particular, claims 1-3, 8-10, and 15 were rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 5,359,236 of Giordano, et al. ("Giordano") in view of U.S. Patent No. 5,287,292 of Kenny, et al. ("Kenny") and U.S. Patent No. 4,807,144 of Joehlin, et al. ("Joehlin"). Claims 4-7, 11-14, and 16-19 under 35 U.S.C. § 103 as being unpatentable Giordano, Kenny, Joehlin, and U.S. Patent No. 5,077,491 of Heck, et al. ("Heck"). Claims 37-39 have been neither rejected nor objected to.

Appellant appeals the rejection of claims 1-19.

## IV. STATUS OF AMENDMENTS

As of March 5, 1998, no amendments have been filed subsequent to the Final Office Action mailed October 16, 1997. Claims 1-19 and 37-39, as currently pending, are set forth in the attached Appendix.

## V. SUMMARY OF THE INVENTION

Claims 1-19 are drawn to a methods and apparatus for detecting whether a temperature within an integrated circuit has attained a programmable threshold temperature. Generally a programmable input provides a value corresponding to a threshold temperature. A voltage reference substantially independent of temperature is provided. A sensing

voltage varying substantially linearly with temperature is generated. The sensing voltage is scaled in accordance with the value to produce a comparison voltage. The comparison voltage and the voltage reference are then compared to determine whether the threshold temperature has been attained.

Method claims 1-7 include the step of generating a voltage reference substantially independent of the temperature of the integrated circuit. A programmable input is used to specify a value corresponding to a threshold temperature for the integrated circuit. A sensing voltage that varies substantially linearly with the temperature of the integrated circuit is generated. The sensing voltage itself is scaled with the value to generate a comparison voltage such that the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially the same as the threshold temperature. A signal is generated when a difference between the comparison voltage and the voltage reference indicates the integrated circuit has attained the threshold temperature.

Apparatus claims 8-14 include a voltage reference means for generating a voltage substantially independent of a temperature of the integrated circuit. At least one programmable input is used to receive a value corresponding to a threshold temperature of the integrated circuit. A temperature sensing means generates a sensing voltage that varies substantially linearly with the temperature of the integrated circuit. The temperature sensing means scales the sensing voltage in accordance with the value to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the integrated circuit attains the threshold temperature. A

comparison means coupled to the temperature sensing means and the voltage reference means generates a signal when the comparison voltage exceeds the voltage reference to indicate that the integrated circuit has attained the threshold temperature.

Apparatus claims 15-19 are more specifically drawn to components which provide the voltage reference, the sensing voltage, the scaling circuitry, and the comparison circuitry. In particular a bandgap reference circuit provides a voltage reference substantially independent of a temperature of the integrated circuit. A bipolar transistor provides a base-to-emitter voltage as a sensing voltage that varies substantially linearly with the temperature of the integrated circuit. A programmable input provides a value corresponding to the desired threshold temperature. A voltage divider scales the sensing voltage in accordance with the value to generate a comparison voltage such that the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially equal to the threshold temperature. A comparator provides a signal when a difference between the comparison voltage and the voltage reference indicates that the threshold temperature has been attained.

## VI. ISSUES PRESENTED

**ISSUE: Whether claims 1-19 were properly rejected under 35 U.S.C. § 103 in view of various combinations of Giordano, Kenny, Joehlin, and Heck.**

**Sub-issue A: The cited references do not teach or suggest all claim limitations**

1. *The references do not teach a method for detecting a threshold temperature in an integrated circuit including receiving a programmable input specifying a value corresponding to a threshold temperature*

2. *The references do not teach scaling the sensing voltage in accordance with a value corresponding to a programmable threshold temperature*

3. *References do not teach comparing scaled sense voltage with temperature independent voltage reference*

**Sub-issue B: No motivation to combine the references**

**Sub-issue C: Combination of references is unworkable**

## VII. GROUPING OF CLAIMS

Claims 1-7 stand together (Group I).

Claims 8-14 stand together (Group II).

Claims 15-19 stand together (Group III).

## VIII. ARGUMENT

**Issue: Whether claims 1-19 were properly rejected under 35 U.S.C. § 103 in view of various combinations of Giordano, Kenny, Joehlin, and Heck.**

Appellant respectfully submits that claims 1-19 are patentable under 35 U.S.C. § 103 in view of Giordano, Kenny, Joehlin, and Heck.

Claims 1-3, 8-10, and 15 were rejected under 35 U.S.C. § 103 as being unpatentable over various combinations of Giordano, Kenny, and Joehlin. Dependent claims 4-7, 11-14, and 16-19 were rejected as being unpatentable over Giordano, Kenny, Joehlin, and Heck.

Appellant will limit the argument to the independent claims representative of each claim grouping. Given that claims 4-7, 11-14, and 16-19 are dependent claims, appellant submits that if their respective independent claims are found to be patentable, claims 4-7, 11-14, and 16-19 must necessarily be patentable. (*see, e.g.*, MPEP §2143.03 citing In re Fine, 5 USPQ2d 1596 (Fed. Cir. 1988) Thus the specific rejections as to 4-7, 11-14, and 16-19 need not be addressed in this appeal.

With respect to claims 1-3, 8-10, and 15, appellant notes that after summarizing Giordano *without any regard to the claim language*, the Examiner has stated:

> Accordingly, Giordano *discloses circuits embodying the invention* include a means for generating a turn-on signal which increases with increasing temperature. This turn-on signal is applied to the control device whose turn-on threshold decreases with temperature.

(10/03/97 Final Office Action, p. 3)

Appellant notes that the Examiner has attempted to reduce the invention to a "gist" or "thrust" effectively disregarding the language of the claims almost entirely.

Appellant respectfully submits that in order to establish a prima facie case of obviousness three basic criteria must be met. 1) There must be some suggestion or motivation either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings; 2) There must be reasonable expectation of success; and 3) The prior art reference (or references) when combined must teach or suggest all of the claim limitations. Furthermore, the teaching or suggestion to make the claimed combination and the

reasonable expectation of success must be found in the prior art, not in appellant's disclosure. (MPEP § 2143 citing In re Vaeck, 20 USPQ2d 1438 (Fed. Cir. 1991).

Appellant respectfully submits that claims 1-19 are patentable in view of the cited references. In particular, appellant submits 1) the combination of references does not teach or suggest all the claim limitations; 2) there is no motivation to combine the references as claimed; and 3) such a combination is unworkable.

## A. The cited references do not teach or suggest all claim limitations

Appellant submits the cited references, alone or combined, do not teach all the claim limitations as discussed below.

### *1. The references do not teach a method for detecting a threshold temperature in an integrated circuit including receiving a programmable input specifying a value corresponding to a threshold temperature*

With respect to Group I, appellant respectfully submits that *none of the cited references, alone or combined, teaches or discloses a method for detecting a threshold temperature in an integrated circuit including the step of receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit.*

Giordano includes a disclosure of a thermal sensor circuit. The thermal sensor circuit of Giordano generates a signal when a predetermined threshold temperature is reached. In particular, Giordano discloses a means of varying a temperature sensitive VBE to vary the rate of change of conduction of a transistor for small temperature variations about a critical temperature. (Giordano, col. 5, line 33 thru col. 6, line 4). Appellant submits

that the critical temperature is established at the time of manufacture through the characteristics of circuit components such as Q1 and R2 (see col. 1, line 26 thru col. 2, line 2 referring to Fig. 1A; Fig. 4; Fig. 2 as a simplified representation of Fig. 4; col. 2, line 46 thru col. 3, line 39). Appellant thus respectfully submits that *the thermal sensor circuit of Giordano is not programmable. Thus Giordano does not teach or disclose a method for detecting a threshold temperature in an integrated circuit including the step of receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit.*

With respect to Kenny, the Examiner has stated:

> Regarding a varying threshold voltage detection, Kenny discloses an integrated circuit to detect programmable threshold in order to sense the temperature of a CMOS integrated circuit. When the programmable threshold value is detected (predetermined temperatures), the CPU speed is decreased or increased accordingly.

(10/03/97 Final Office Action, p. 4)

Appellant respectfully traverses the Examiner's characterization of Kenny. Kenny includes a disclosure of a heat regulator for integrated circuits. The temperature of the integrated circuit is either 1) measured directly with a temperature monitor, or 2) indirectly estimated from a measure of the activity of the integrated circuit. (Kenny, col. 1, line 51 thru col. 2, line 2). Kenny does not teach or disclose a "programmable threshold in order to sense the temperature of a CMOS integrated circuit."

Appellant respectfully submits that the direct measuring temperature monitor taught by Kenny is *not programmable*. Referring to Figure 5, the temperature is measured by using a voltage divider including a temperature dependent resistor (501). The voltage divider provides a signal 505 to a power

use regulator 502. When signal 505 reaches a trigger value, the power use regulator activates (Kenny, col., 9, lines 40-45). There is no indication that the trigger level is programmable. *Thus Kenny's "direct method" does not teach or disclose a method for detecting a threshold temperature in an integrated circuit including the step of receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit.*

With respect to the "indirect method" of measuring temperature, appellant points out that the indirect method *does not actually measure temperature.* Instead, counters are used to accumulate a count corresponding to the length of time that the CPU is operating at various frequencies. (Kenny, col. 5, line 42 thru col. 6, line 22). The counter increments when the CPU is operating at one frequency and decrements when the CPU is operating at another frequency. If the counter reaches a threshold value, a regulating signal is generated to force the CPU to a slower clock speed. (Kenny, col. 5, lines 58 thru col. 6, line 5).

Even if different "threshold values" can be used, the threshold values merely change the length of time that the CPU operates at higher clock frequencies regardless of the temperature of the CPU. Given that Kenny's threshold value is independent of temperature, the value cannot correspond to a threshold temperature for the integrated circuit. *Thus Kenny's "indirect method" does not teach or disclose a method for detecting a threshold temperature in an integrated circuit including the step of receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit.*

Joehlin includes a disclosure of a temperature control system for a glass sheet furnace. A glass sheet processing system includes a furnace and a conveyor. An automatic temperature monitoring and control system includes a temperature sensor mounted at a pre-selected location in the system, a display, and a computer connected to the temperature sensor for periodically receiving a series of signals corresponding to temperature values transmitted by the sensor. The computer also includes memory for storing selected values received from the temperature sensor as well as one or more pre-selected threshold values and control logic for comparing the temperature values with one or more of the pre-selected threshold values. (Joehlin, col. 4, lines 63 thru col. 5, line

Appellant respectfully submits Joehlin's glass furnace is not equivalent to an integrated circuit. Moreover, the programmable inputs are used to specify thresholds for temperatures of the glass, not the computer or any integrated circuit. Joehlin does not teach or suggest *a method for detecting a threshold temperature in an integrated circuit including the step of receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit.*

Heck has apparently been cited merely as an example of a comparator circuit and thus does not teach or suggest detecting a threshold temperature in an integrated circuit or receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit.

Thus appellant respectfully submits that *none of the cited references, alone or combined, teaches or discloses a method for detecting a threshold*

*temperature in an integrated circuit including the step of receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit.*

In contrast, Group I includes the language:

> 1. *A method for detecting a threshold temperature in an integrated circuit comprising the steps of:*
>
> • • •
>
> *receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit;*
> generating a sensing voltage that varies substantially linearly with the temperature of the integrated circuit;
>
> • • •

(Group I: Claim 1)(*emphasis added*).

Appellant respectfully submits that the same arguments presented above with respect to method claim 1 similarly apply to apparatus claims 8 and 15. In particular, none of the cited references, alone or combined, teaches or discloses an apparatus for detecting a threshold temperature in an integrated circuit including at least one programmable input for receiving a value corresponding to a threshold temperature of the integrated circuit.

In contrast, Groups II and III include the language:

> 8. *An apparatus for detecting a threshold temperature in an integrated circuit comprising:*
>
> • • •
>
> *at least one programmable input for receiving a value corresponding to a threshold temperature of the integrated circuit;*
>
> • • •

(Group II: Claim 8)(*emphasis added*).

> 15. *An apparatus for detecting a threshold temperature in an integrated circuit comprising:*
>
> • • •
>
> *at least one programmable input receiving a value corresponding to a threshold temperature for the integrated circuit;*

• • •

(Group III: Claim 15)(*emphasis added*).

Thus appellant respectfully submits Groups I-III are patentable under 35 U.S.C. § 103 in view of the cited references.

***2. The references do not teach scaling the sensing voltage in accordance with a value corresponding to a programmable threshold temperature***

Appellant respectfully submits that *none of the references alone or combined, teaches or discloses a method for detecting a threshold temperature in an integrated circuit including the step of scaling a sensing voltage in accordance with a value corresponding to a programmable threshold temperature, wherein the comparison voltage is substantially equal to a voltage reference when the temperature of the integrated circuit is substantially the same as the threshold temperature.*

With respect to Giordano, the Examiner has stated:

> Giordano also discloses that the integrated thermal sensor includes a current source to generate the turn-on (or control) voltage (signal) which is increased linearly as a function of increasing temperature (col 3, lines 2-5, col 5 and Figs. 2 & 4). *Thus this control voltage V14 is scaling to proportionally and linearly with increasing temperature. Additionally to the scaling of the sensing voltage of Giordano...*

(10/03/97 Final Office Action, pp. 3-4)(*emphasis added*).

The Examiner has also stated:

> Responding to the applicant's remark that Giordano, Kenny do not teach a method for detecting a threshold temperature in an integrated circuit including the step of receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit, the examiner respectfully disagrees. Giordano teaches a thermal sensor used for detecting a threshold temperature when reference voltage equals to the sensing voltage (Vbe). *Giordano provides an example if the Vbe equals to Vref, thus the thermal sensor*

> *would detect a threshold temperature for example 75 degrees (col. 1, lines 26-78) when Vbe equals to Vref. Accordingly, practitioners in the art would have motivated to program the thermal sensor by providing different input signal in order to providing different sensing voltage output corresponding to different threshold temperature because this would have more advantage because the thermal sensor can detect different threshold temperature.*

(10/03/97 Final Office Action, p. 7)(*emphasis added*).

Appellant has claimed scaling the sensing voltage not the voltage reference. Appellant is unsure as to whether the Examiner is analogizing Giordano's control voltage to the claimed voltage reference or the claimed sensing voltage or even the claimed comparison voltage.

On the one hand the Examiner appears to analogize the control voltage at V14 to the claimed sensing voltage or perhaps the scaled sensing voltage. Appellant has claimed scaling the sensing voltage in accordance with a programmable input value to provide a comparison voltage. Is the Examiner proposing that V14 is both the sensing voltage before scaling and the sensing voltage after scaling (comparison voltage)? This is clearly in error because there is no scaling with respect to voltages at the same node (i.e., V14 = V14), moreover the Vbe of Q1 is used to sense the temperature in both the prior art of Figure 1A and the circuit of Figure 4.

On the other hand the Examiner appears to be saying that the prior art $KV_{BG}$ control voltage could be varied to provide for detecting different threshold temperatures. Giordano's $KV_{BG}$, however, is substantially independent of temperature and thus corresponds most accurately to the claimed voltage reference. Scaling the voltage reference is contrary to what appellant has claimed. Appellant has claimed scaling the sensing voltage, not the voltage reference.

Appellant would appreciate a commitment as to whether the voltage at Giordano's node V14 is being analogized to the claimed sensing voltage, comparison voltage, or reference voltage and to use the analogy consistently.

To the extent appellant understands the Examiner's rejection and comments, appellant respectfully traverses the Examiner's characterization of Giordano.

As best as appellant understands the remarks, the Examiner is attempting to analogize the control voltage at node 14 of Giordano with appellant's sensing voltage and further that the same node represents the scaled sensing voltage (i.e., comparison voltage). Appellant respectfully submits that the voltage at node 14 does not represent both a sensing voltage and a scaled sensing voltage (i.e., comparison voltage) because V14 = V14.

Giordano has replaced the prior art voltage reference $KV_{BG}$ with a more sophisticated circuitry, but the role of the sensing device Q1 has not changed. The Vbe of Q1 is used for sensing the temperature. Apparently the Examiner has improperly analogized appellant's sensing voltage to Giordano's control voltage rather than the Vbe of Q1, *and even if the analogy is proper there is no scaling of the sensing voltage in accordance with a programmable input value.* Appellant further points out that if the Examiner relies on Figure 4 for the scaling of the sensing voltage, where is the claimed temperature independent voltage reference? Both Vbe and V14 vary with the temperature.

Giordano uses a compensated control voltage V14 with a $V_{BE}$ voltage to determine if a critical temperature is reached. Thus appellant's sensing voltage and voltage reference must be analogized to Giordano's control and

$V_{BE}$ voltages. Giordano's prior art clearly indicates that $KV_{BG}$ is substantially independent of temperature (Giordano, Fig. 1A). $KV_{BG}$ was replaced with a control voltage that varies with temperature (Giordano, Fig. 4, node V14). Appellant submits Giordano's control voltage is better analogized to the claimed voltage reference, however, the control voltage at V14 is not substantially independent of temperature as claimed, but neither is $V_{BE}$. Whether the sensing voltage is analogized to Giordano's control voltage or $V_{BE}$ is irrelevant given that neither is "scaled" in accordance with a programmable value.

Appellant respectfully submits that there is no "scaling" in Giordano as proposed by the Examiner. Figure 2 is a simplification of the circuitry of Figure 4. Although the voltage at node 14 increases as a result of increases in current from current source 10, there is no "scaling of the sensing voltage" (either Vbe of Q1 or V14) as alleged by the Examiner. Certainly there is no scaling in accordance with a programmable input value given that Giordano's temperature sensor is not programmable.

The control voltage at node 14 is produced as a result of current from current source 10 passing through resistor R2. Without R2, there is no control voltage at node 14. Although the control voltage at node 14 is related to the value of resistor R2, resistor R2 is fixed in value at the time of manufacture. Resistor R2 does not scale the control voltage. To the contrary, resistor R2 produces the control voltage. Appellant therefore respectfully submits that there is no "scaling of the sensing voltage of Giordano" as proposed by the Examiner.

Moreover, appellant respectfully submits that the thermal sensor of Giordano is not programmable. *As a result, Giordano does not teach or disclose scaling the sensing voltage in accordance with the value corresponding to a programmable threshold temperature.*

*Thus Giordano does not teach or disclose a method for detecting a threshold temperature in an integrated circuit including the step of scaling a sensing voltage in accordance with a value corresponding to a programmable threshold temperature, wherein the comparison voltage is substantially equal to a voltage reference when the temperature of the integrated circuit is substantially the same as the threshold temperature.*

With respect to Kenny, appellant maintains that only the "direct" method measures temperature. The "direct" method, however, does not provide for programmable threshold temperatures. The threshold temperature is determined at the time of manufacture. Although the "indirect" method provides for programmable thresholds, these thresholds are merely indicate how long the CPU can operate at various clock frequencies - *not the temperature of the CPU.* The indirect method does not even measure temperature. The indirect method does not provide a sensing voltage that varies with the temperature of the CPU.

Clearly, if there is no sensing voltage there is no scaling of the sensing voltage. Thus appellant respectfully submits Kenny *does not teach or disclose a method for detecting a threshold temperature in an integrated circuit including the step of scaling the sensing voltage in accordance with a value corresponding to a programmable threshold temperature, wherein the comparison voltage is substantially equal to a voltage reference when the*

*temperature of the integrated circuit is substantially the same as the threshold temperature.*

Joehlin discloses using a temperature sensor in conjunction with an analog-to-digital converter in order to convert the analog signal transmitted by the thermal sensor to the computer. (Joehlin, col. 5, lines 51-60). The system obtains a digital value corresponding to a temperature reading from the sensor at initialization. Appellant submits that Joehlin does not teach or disclose scaling a sensing voltage in accordance with a value corresponding to a programmable threshold temperature.

Heck again apparently has been cited only as an example of a comparator circuit.

Group I, however, includes the language:

> 1. A method for detecting a threshold temperature in an integrated circuit comprising the steps of:
> generating a voltage reference that is substantially independent of a temperature of the integrated circuit;
> receiving at least one programmable input *specifying a value corresponding to a threshold temperature for the integrated circuit;*
> generating a sensing voltage that varies substantially linearly with the temperature of the integrated circuit;
> *scaling the sensing voltage in accordance with the value to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially the same as the threshold temperature;* and
> generating a signal when a difference between the comparison voltage and the voltage reference indicates the integrated circuit has attained said threshold temperature.

(Group I: Claim 1)(*emphasis added*).

With respect to Group II, appellant respectfully submits that the arguments presented above with respect to Group I similarly apply. In

particular, none of the cited references, alone or combined, teaches or discloses an apparatus for detecting a threshold temperature in an integrated circuit including temperature sensing means for generating a sensing voltage, the temperature sensing means scaling the sensing voltage in accordance with a value corresponding to a programmable temperature threshold to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the integrated circuit attains the threshold temperature.

In contrast, Group II includes the language:

> 8. *An apparatus for detecting a threshold temperature in an integrated circuit comprising:*
>
> voltage reference means for generating a voltage reference substantially independent of a temperature of the integrated circuit;
>
> at least one programmable input for *receiving a value corresponding to a threshold temperature of the integrated circuit;*
>
> *temperature sensing means for generating a sensing voltage wherein the sensing voltage varies substantially linearly with the temperature of the integrated circuit, the temperature sensing means scaling the sensing voltage in accordance with the value to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the integrated circuit attains the threshold temperature;* and
>
> comparison means coupled to the temperature sensing means and the voltage reference means, wherein the comparison means generates a signal when the comparison voltage exceeds the voltage reference to indicate the integrated circuit temperature attained the threshold temperature.

(Group II: Claim 8)(*emphasis added*)

With respect to Group III, appellant respectfully submits that the cited references do not teach or disclose an apparatus for detecting a threshold temperature in an integrated circuit including a voltage divider wherein the voltage divider scales Vbe in accordance with a value corresponding to a

threshold temperature to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially equal to the threshold temperature.

In contrast, Group III includes the language:

> 15. An apparatus for detecting a threshold temperature in an integrated circuit comprising:
>
> a bandgap reference circuit providing a voltage reference substantially independent of a temperature of the integrated circuit;
>
> *a bipolar transistor providing a base-to-emitter voltage (Vbe) as a sensing voltage, wherein the sensing voltage varies substantially linearly with the temperature of the integrated circuit;*
>
> at least one programmable input *receiving a value corresponding to a threshold temperature for the integrated circuit;*
>
> a voltage divider coupled to the bipolar transistor, *wherein the voltage divider scales Vbe in accordance with the value to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially equal to the threshold temperature;* and
>
> a comparator providing a signal when a difference between the comparison voltage and the voltage reference indicates that the threshold temperature has been attained.

(Group III: Claim 15)(*emphasis added*)

In view of the arguments presented above, appellant respectfully submits Groups I-III are patentable under 35 U.S.C. § 103 in view of the cited references.

### 3. *References do not teach comparing scaled sense voltage with temperature independent voltage reference*

Appellant notes that the temperature independent reference voltage $KV_{BG}$ of Giordano in Figure 1A was replaced with the more sophisticated circuitry of Figure 4. The circuits are mutually exclusive as one replaced the other. Whatever interpretation is made of the Examiner's analogy of the

claimed sensing voltage to the circuitry of Figure 4, appellant submits that such analogy necessarily eliminates the temperature independent voltage reference contrary to what is claimed by appellant.

In other words, in Giordano's Figure 1A the Vbe of Q1 is not scaled, but it is compared to a constant reference voltage. The Examiner has relied on Figure 4 to show "scaling." Assuming arguendo that the Examiner's statements are true in that the sensing voltage is scaled, appellant submits that the "scaled sensing voltage" is not compared with a temperature independent voltage reference. To the contrary, the sophisticated circuitry of Giordano's Figure 4 deliberately ensures that the Vbe and V1 both vary with temperature. The temperature independent voltage reference was replaced. Moreover, the Examiner cannot rely on Figure 1A for the temperature independent voltage reference, because the sophisticated circuitry of Figure 4 would be replaced by $KV_{BG}$ thus eliminating the required "scaled sensing voltage". The circuitry of Figures 1A and 4 cannot be combined to teach both a scaled sensing voltage and a temperature independent voltage reference.

In contrast, claims 1, 8, and 15 include the language:

> 1. A method for detecting a threshold temperature in an integrated circuit comprising the steps of:
> *generating a voltage reference that is substantially independent of a temperature of the integrated circuit;*
> receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit;
> *generating a sensing voltage that varies substantially linearly with the temperature of the integrated circuit;*
> *scaling the sensing voltage in accordance with the value to generate a comparison voltage,* wherein the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially the same as the threshold temperature; and

• • •

(Group I: Claim 1)(*emphasis added*)

> 8. An apparatus for detecting a threshold temperature in an integrated circuit comprising:
>
> *voltage reference means for generating a voltage reference substantially independent of a temperature of the integrated circuit;*
>
> at least one programmable input for receiving a value corresponding to a threshold temperature of the integrated circuit;
>
> *temperature sensing means for generating a sensing voltage wherein the sensing voltage varies substantially linearly with the temperature of the integrated circuit, the temperature sensing means scaling the sensing voltage in accordance with the value to generate a comparison voltage,* wherein the comparison voltage is substantially equal to the voltage reference when the integrated circuit attains the threshold temperature; and
>
> • • •

(Group II: Claim 8)(*emphasis added*)

> 15. An apparatus for detecting a threshold temperature in an integrated circuit comprising:
>
> *a bandgap reference circuit providing a voltage reference substantially independent of a temperature of the integrated circuit;*
>
> *a bipolar transistor providing a base-to-emitter voltage (Vbe) as a sensing voltage, wherein the sensing voltage varies substantially linearly with the temperature of the integrated circuit;*
>
> at least one programmable input receiving a value corresponding to a threshold temperature for the integrated circuit;
>
> a voltage divider coupled to the bipolar transistor, *wherein the voltage divider scales Vbe in accordance with the value to generate a comparison voltage,* wherein the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially equal to the threshold temperature; and
>
> • • •

(Group III: Claim 15)(*emphasis added*)

Thus appellant respectfully submits Groups I-III are patentable under 35 U.S.C. § 103 in view of the cited references.

## B. No motivation to combine the references

The Examiner has stated:

> Therefore with the motivation of detecting a programmable threshold according to programmable input signals as taught by Joehlin, one of ordinary skill in the art at the time the invention was made would have found it obvious to combine the teachings of Giordano, Kenny, and Joehlin to provide a programmable thermal sensor circuit because this programmable thermal sensor would detect a variety of threshold temperatures in an integrated circuit upon receiving programmable inputs specifying a value corresponding to a threshold temperature the integrated circuit as taught by Joehlin (see abstract, summary, col 5, lines 13-24), thereby it would saves the cost of a cooling fan or heat sink since it is virtually free when implementing on an existing circuit as suggested by Kenny (col 5, lines 11-13) and then improve the thermal sensor performance.

(10/13/97 Final Office Action, pp. 4-5)

Appellant respectfully submits that this "motivation" is clearly contrived. The Examiner has merely lifted a "gist" from each of the references in an attempt to contrive the stated combination.

Giordano has been cited as a thermal sensor. Kenny has been cited for variable threshold temperature detection. Joehlin has been cited as a method for detecting a threshold temperature including the step of receiving at least one programmable input specifying a value corresponding to a threshold temperature.

With respect to Kenny, the Examiner has stated:

> Regarding a varying threshold voltage detection, Kenny discloses an integrated circuit to detect programmable threshold in order to sense the temperature of a CMOS integrated circuit. When the programmable threshold value is detected (*predetermined temperatures*), the CPU speed is decreased or increased accordingly.

(10/03/97 Final Office Action, p. 4)(*emphasis added*)

Appellant respectfully traverses the Examiner's characterization of Kenny. Kenny includes a disclosure of a heat regulator for integrated circuits. The temperature of the integrated circuit is either 1) measured directly with a temperature monitor, or 2) indirectly estimated from a measure of the activity of the integrated circuit. (Kenny, col. 1, line 51 thru col. 2, line 2). Kenny does not teach or disclose a "programmable threshold in order to sense the temperature of a CMOS integrated circuit" as alleged.

Appellant respectfully submits that the direct measuring temperature monitor taught by Kenny is *not programmable.* Referring to Figure 5, the temperature is measured by using a voltage divider including a temperature dependent resistor (501). The voltage divider provides a signal 505 to a power use regulator 502. When signal 505 reaches a trigger value, the power use regulator activates (Kenny, col., 9, lines 40-45).

With respect to the "indirect method" of measuring temperature, appellant points out that the indirect method *does not actually measure temperature.* Instead, counters are used to accumulate a count corresponding to the length of time that the CPU is operating at various frequencies. (Kenny, col. 5, line 42 thru col. 6, line 22). The counter increments when the CPU is operating at one frequency and decrements when the CPU is operating at another frequency. If the counter reaches a threshold value, a regulating signal is generated to force the CPU to a slower clock speed. (Kenny, col. 5, lines 58 thru col. 6, line 5). Even if different "threshold values" can be used, the threshold values change the length of time that the CPU operates at higher clock frequencies independent of the temperature of the CPU.

Therefore appellant finds the Examiner's rationale for combining or modifying the references to be without merit. The only "programmable thresholds" in Kenny are with respect to the indirect method of measuring temperature which is actually only a measure of the length of time a CPU is running. Thus Giordano is inapplicable with Kenny's indirect method. If the thermal sensor of Giordano is substituted for the thermal sensor of Kenny when using the direct method, appellant submits that such a combination cannot be motivated by a desire to have a programmable thermal sensor because neither the direct method of Kenny nor the thermal sensor of Giordano provide for a programmable thermal sensor.

Appellant respectfully submits that because such a combination obviously would not achieve the object of the stated motivation, the argument that such motivation exists is nonsensical.

## C. Combination of references unworkable.

The Examiner has attempted to lift the "gist" or "thrust" of a few references in order to combine them into a workable teaching of what is claimed. Appellant respectfully submits, however, that the Examiner's proposed combination appears unworkable.

For example, as stated above, appellant is uncertain as to how the Examiner would combine Kenny, Joehlin, and Giordano to provide the claimed programmable thermal sensor as alleged by the Examiner.

For example, does the Examiner propose substituting the thermal sensor of Giordano for the thermal sensor of Joehlin? If so, is there further modification of Giordano since Giordano is not programmable and does not

provide an external signal other than to simply indicate when the threshold temperature (determined at the time of manufacture) has been attained?

With respect to combining Kenny and Giordano, the temperature monitor of Kenny's direct method is not programmable. Given that Giordano's thermal sensor is similarly non-programmable, the substitution or addition of Giordano's thermal sensor for that of Kenny still results in a non-programmable thermal sensor. Moreover there is no motivation to have Joehlin's programmable inputs for temperature thresholds if neither Kenny's thermal monitor nor Giordano's thermal sensor are programmable.

With respect to Kenny's indirect method, *no temperature sensor is used*. Moreover, the programmable thresholds are with respect to the length of time a processor is running at a particular frequency *independent of the temperature*. Thus Giordano's temperature sensor would be useless. Similarly, Joehlin's programmable temperature threshold inputs would be useless without a thermal sensor providing temperature information for comparison with the threshold values.

Finally, other than combining the "gist" of programmability with the "gist" of thermal sensing, the Examiner has not indicated how thresholds used for comparison within Joehlin's computer could actually be used in conjunction with the sensor of Giordano, to provide for a programmable thermal sensor. Giordano simply provides a binary signal indicative of whether a pre-determined temperature threshold has been attained. How is Joehlin to utilize this data? Alternatively, Giordano's temperature threshold is fixed at the time of manufacture, thus how would Joehlin's programmable

thresholds be provided to Giordano in order to change Giordano into a programmable thermal sensor?

Appellant respectfully submits that the references are not combinable in a workable fashion, at least not as alleged by the Examiner.

## IX. CONCLUSION

Appellant respectfully submits that the stated rejections cannot be maintained in view of the arguments set forth above. Appellant respectfully submits that all of claims 1-19 including Groups I, II, and III are patentable over Giordano, Kenny, Joehlin, and Heck under 35 U.S.C. § 103 and requests that the Board of Patent Appeals and Interferences direct allowance of the rejected claims.

If there are any issues that can be resolved by telephone conference, the undersigned representative of the appellant may be contacted at **(503) 684-6200.**

If there are any additional charges associated with this communication, please charge Deposit Account No. 02-2666.

Respectfully submitted,
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Date: March 5, 1998

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# APPENDIX

Claims 1-19 and 37-39 are presented as follows:

1. A method for detecting a threshold temperature in an integrated circuit comprising the steps of:

generating a voltage reference that is substantially independent of a temperature of the integrated circuit;

receiving at least one programmable input specifying a value corresponding to a threshold temperature for the integrated circuit;

generating a sensing voltage that varies substantially linearly with the temperature of the integrated circuit;

scaling the sensing voltage in accordance with the value to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially the same as the threshold temperature; and

generating a signal when a difference between the comparison voltage and the voltage reference indicates the integrated circuit has attained said threshold temperature.

2. The method of claim 1 wherein the step of generating the voltage reference further comprises the step of generating a silicon bandgap voltage reference.

3. The method of claim 1 wherein the step of generating the sensing voltage further comprises the step of generating a base-to-emitter voltage (Vbe) from a bipolar transistor.

4. The method of claim 3 wherein the step of scaling the sensing voltage further comprises the step of selecting a bias of the bipolar transistor in accordance with the value.

5. The method of claim 4 further comprising the steps of:

providing a first resistive element coupled to a base and a collector of the bipolar transistor;

providing a plurality of series coupled resistors to form a second resistive element coupled to the base and an emitter of the bipolar transistor; and

shorting a combination of the plurality of series-coupled resistors in accordance with the value to select the bias of the bipolar transistor.

6. The method as claimed in claim 5 wherein the plurality of resistors comprises a plurality of binary weighted resistors.

7. The method as claimed in claim 1 wherein the integrated circuit comprises a microprocessor.

8. An apparatus for detecting a threshold temperature in an integrated circuit comprising:

voltage reference means for generating a voltage reference substantially independent of a temperature of the integrated circuit;

at least one programmable input for receiving a value corresponding to a threshold temperature of the integrated circuit;

temperature sensing means for generating a sensing voltage wherein the sensing voltage varies substantially linearly with the temperature of the integrated circuit, the temperature sensing means scaling the sensing voltage in accordance with the value to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the integrated circuit attains the threshold temperature; and

comparison means coupled to the temperature sensing means and the voltage reference means, wherein the comparison means generates a signal when the comparison voltage exceeds the voltage reference to indicate the integrated circuit temperature attained the threshold temperature.

9. The apparatus of claim 8 wherein the voltage reference is a silicon bandgap voltage reference.

10. The apparatus of claim 8 wherein the temperature sensing means further comprises a bipolar transistor for generating a base-to-emitter voltage as the sensing voltage.

11. The apparatus as claimed in claim 10 further comprising a plurality of resistive elements, wherein a first resistive element is coupled from a base to a collector of the bipolar transistor, and a second resistive element is coupled from the base of said bipolar transistor to an emitter of the bipolar transistor.

12. The apparatus of claim 11 wherein the second resistive element comprises a plurality of series-coupled resistors, wherein at least one transistor is coupled across each of some of the plurality of resistors, wherein a combination of the resistors is selected in accordance with the value.

13. The apparatus of claim 11 wherein the resistors comprise a plurality of binary weighted resistors.

14. The apparatus of claim 8 wherein the integrated circuit comprises a microprocessor.

15. An apparatus for detecting a threshold temperature in an integrated circuit comprising:

a bandgap reference circuit providing a voltage reference substantially independent of a temperature of the integrated circuit;

a bipolar transistor providing a base-to-emitter voltage (Vbe) as a sensing voltage, wherein the sensing voltage varies substantially linearly with the temperature of the integrated circuit;

at least one programmable input receiving a value corresponding to a threshold temperature for the integrated circuit;

a voltage divider coupled to the bipolar transistor, wherein the voltage divider scales Vbe in accordance with the value to generate a comparison voltage, wherein the comparison voltage is substantially equal to the voltage reference when the temperature of the integrated circuit is substantially equal to the threshold temperature; and

a comparator providing a signal when a difference between the comparison voltage and the voltage reference indicates that the threshold temperature has been attained.

16. The apparatus of claim 15 wherein the voltage divider comprises a first resistive element coupled from a base to a collector of the bipolar transistor and a second resistive element coupled from the base to an emitter of the bipolar transistor.

17. The apparatus of claim 16 further comprising:

a plurality of series-coupled resistors forming the second resistive element; and

a plurality of transistors, at least one of each of the plurality of transistors coupled across one of the plurality of resistors, wherein the plurality of transistors select a combination of resistors in accordance with the value to provide a bias voltage for the bipolar transistor.

18. The apparatus of claim 16 resistors comprise a plurality of binary weighted resistors.

19. The apparatus of claim 15 wherein the integrated circuit comprises a microprocessor.

37. An integrated circuit microprocessor on a semiconductor die, comprising:

a programmable thermal sensor providing a temperature signal corresponding to a temperature within the microprocessor, the semiconductor die having a first area and a second area, the first area having a higher temperature than the second area, the thermal sensor positioned proximate the first area; and

sense circuitry coupled to provide an output signal in response to the temperature signal, the sense circuitry providing the output signal when the temperature signal is in a predetermined relationship with a reference signal.

38. An apparatus for providing an indicator signal in response to a temperature of an integrated circuit, the apparatus being integrated within the integrated circuit and comprising:

a register that stores a value corresponding to a threshold temperature;

a thermal sensor that generates a temperature signal related to the temperature in accordance with the value;

a sense circuit coupled to the thermal sensor, the sense circuit providing the indicator signal when the temperature signal indicates that the temperature exceeds the threshold temperature.

39. An integrated circuit apparatus for providing a control signal in response to a temperature of the integrated circuit, comprising:

a current source providing a current;

a voltage reference circuit coupled to the current source to provide a reference voltage, the voltage reference circuit cooperating with the current source to maintain the reference voltage substantially independent of the temperature;

a thermal sensor coupled to the current source to provide a temperature signal in accordance with a programmable impedance, the temperature signal corresponding to the temperature;

a sense circuit coupled to receive the reference voltage and the temperature signal, the sense circuit providing the control signal when the temperature signal exceeds the reference voltage.